Millimeter Wave Radar Facility

Shelters housing the high-power 94 GHz radar

FUNCTION: Experimental high-power 94 GHz tracking radar system (WARLOC) for use in research involving target cross section measurement, propagation effects, radar imaging, cloud research, and other research that requires very high range and angular resolution.

INSTRUMENTATION: Real-time radar control, signal processing, and image formation are accomplished with a VME-based system. An optical tracking system is mounted on the antenna to help in target acquisition at short range.

DESCRIPTION: The WARLOC radar is housed in a relocatable radar facility that consists of two equipment shelters, a chiller for cooling the transmitter, and a 175 kVA diesel generator for use at remote sites. A 40-ft long shelter houses the transmitter power supply, modulator, and gyro-klystron and incorporates structures to provide a pedestal base for the roof-mounted tracking antenna. A second 20-ft shelter contains the receiver, exciter, signal processing, and recording equipment. Data recording at rates up to 80 MB/s and a capacity of more the 200 GB is available. The transmitter is capable of producing 10 kW of average power with a variety of waveforms suitable for precision tracking and imaging of targets at long range. Waveforms with a bandwidth of 600 MHz can be transmitted at full power. A 6-ft Cassegrain antenna is mounted on a precision pedestal and achieves 62 dB of gain.

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LOCATION:

Relocatable Facility • Chesapeake Bay Detachment, Chesapeake Beach, MD

Radar Imaging Facility

Radar Imaging Facility Raid Storage System, real-time processor, and VLDS recorder units

FUNCTION: Provides the capability to produce real-time and nonreal-time radar imagery (SAR and ISAR). This facility contains the processing, data storage, and the image display and recording resources to handle data from a number of platforms and also serves as an environment for the development of advanced imaging algorithms.

EQUIPMENT: The facility provides VLDS data recorders for playback of data tapes and standard video generation and recording capability for the production of live video recordings. Two VME-based systems are available for interfacing other data recorders, custom interfaces, or other VME-based instrumentation.

DESCRIPTION: The Radar Imaging Facility is housed in a secure vault. The general computing resources that are available include three sun workstations, three SGI workstations, and two PC-based workstations (running Linux). In addition, there are two VME-based multiprocessor systems; one system with four I-860 processors and one system with 12 Power-PC processors, which provide real-time processing capability. Data storage is provided by two Raid systems, with a combined storage capacity of 650 GB. All systems are connected by a 100 Mbs network, which also provides connectivity to the other branch facilities. Video scan converters provide the capability to record the video from any of the workstations and real-time processors and a separate video facility provides video editing capabilities.

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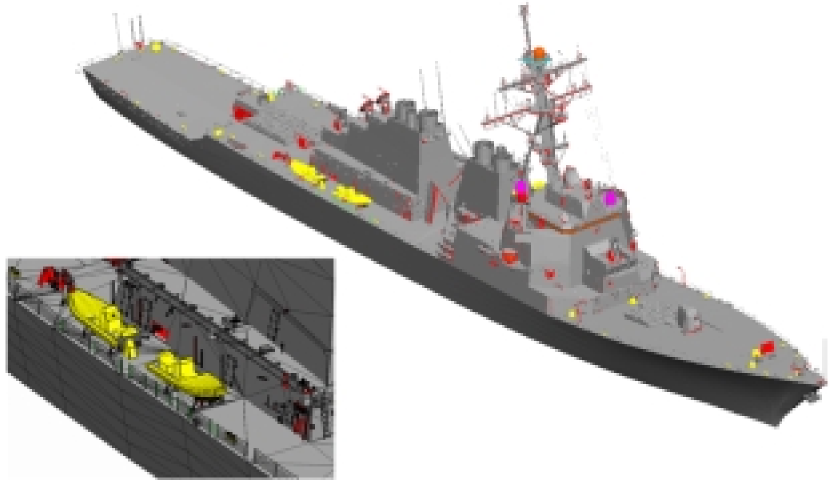
Radar Signature Calculation Facility



CAD model of USS *The Sullivans* (DDG-68)

FUNCTION: Calculates, analyzes, and visualizes the spatially extended radar signatures of complex objects such as ships in a sea multipath environment and phased array antennas. Radar signatures that are typically calculated include total radar cross section (RCS), high-range resolution (HRR) profiles, and inverse synthetic aperture (ISAR) images. The facility has been used on numerous Navy programs, including the design and live fire test and evaluation of the DDG-51 and LPD-17 class ships.

INSTRUMENTATION: The facility currently consists of a Silicon Graphics Origin 2400 parallel computer with 24 processors and 24 GB of physical memory, a Silicon Graphics Octane graphics workstation with 2 processors and 2 GB of physical memory, a DEC with 3 processors and 1 GB of physical memory, several smaller UNIX workstations and INTEL x86 computers, and a Motorola network encryption system (NES) for secure communications with other facilities.

DESCRIPTION: The facility consists of several high-performance computers for calculating the radar signatures of complex objects such as ships and phased array antennas. The radar signatures are calculated from computer-aided design (CAD) models that describe the geometry and material properties of objects. The facility currently includes models of the FFG-7, DD-963, DDG-51, CG-47, PC-9, LPD-17, and CVN-68 class ships. A large collection of CAD models of individual ship components such as antennas, weapons systems, and deck equipment is also available. The radar signatures of large objects are calculated using the Radar Target Signature (RTS) model. The RTS model is based on high-frequency scattering techniques and was developed by the Radar Division specifically for calculating the radar signature of ships in a sea multipath environment. The radar signature of smaller objects such as phased array antennas can be accurately calculated using any of several low-frequency, computational EM software packages available within the facility.

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Airborne Early Warning Radar Facility

Ten-element AAFTE airborne radar array antenna

FUNCTION: Collects, reduces, and analyzes airborne radar data and identifes, develops, and evaluates new techniques for improving the performance of airborne radars. Nearly all new techniques require radars employing multi-element, multichannel antenna arrays. Of particular interest is Space Time Adaptive Processing (STAP), a technique for optimizing radar detection performance in the presence of jamming and clutter.

INSTRUMENTATION: Includes an extensively modified APS-125 radar receiver system; the 10-element Adaptive Array Flight Test Equipment (AAFTE) antenna for collecting multichannel airborne array radar data; a rack mounted STAP pre- and post-processor; a simulation and evaluation suite; and three UNIX computer workstations.

DESCRIPTION: The facility includes a data and signal processing laboratory in Bldg. 60, and the 10-element AAFTE airborne radar array antenna and STAP laboratory currently located in Bldg. 56. Data collected using the AAFTE antenna were used in the first successful demonstration of STAP processing.

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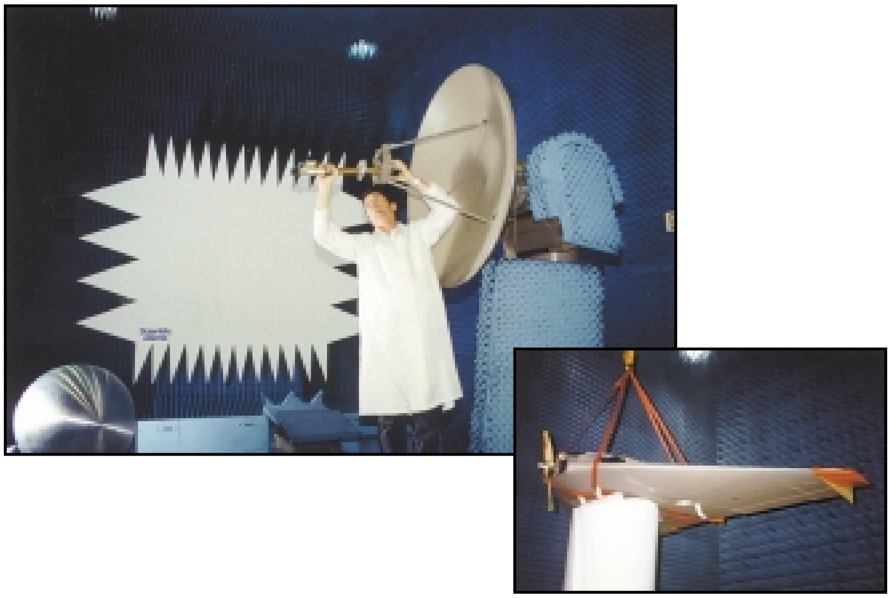
Compact Range Facility



Compact Range Facility

FUNCTION: Measures antenna properties and characteristics and performs radar cross section (RCS) measurements of various objects. These data are used to verify and optimize the designs of new or existing platforms.

INSTRUMENTATION: The facility contains an HP 8530 microwave receiver capable of operating from 2-110 GHz, a 5-axis positioner/controller, a pulsed CW system for radar cross section measurements, and a nearfield scanner that is controlled by the MI Technologies Model MI-3000 Automated Measurement System. The compact range data collection is controlled by a FR 959 antenna/RCS software package using two 700 MHz Windows NT computer systems. Off-line RCS imaging (ISAR) is performed using Knowbell System Software.

DESCRIPTION: The facility is jointly operated by the Space Systems Development Department and the Radar Division. It contains a Scientific Atlanta Model 5706M compact range reflector that produces simulated farfield conditions from 1-110 GHz with a quiet zone (maximum usable size) of approximately 7 ft in diameter and 8 ft in length. The compact range reflector system is positioned inside a 20 × 20 × 40-ft room that is lined with microwave absorbing material to reduce internal reflections to a negligible level. The back wall of the chamber (which receives the majority of the energy) is covered with 24-in. and the sides, floor, and ceiling are covered with 12-in. pyramidal shaped absorber. The chamber also includes an 18 × 12 ft nearfield scanner, which can be configured for planar, cylindrical, or spherical nearfield measurements.

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Airborne Surveillance Command and Control (ASC^2) Research Platform

Airborne Surveillance Command and Control (ASC^2) research aircraft

FUNCTION: Acts as a surrogate for carrier-based surveillance, engagement, communication relay, combat identification, command and control capable assets of the evolving family of systems warfare architecture. In addition to the integrated AN/APS-145 based AEW/CEC suites, the aircraft is designed to accommodate Command and Control (C^2), Electronic Warfare (EW), Radar, and Electro-Optics (EO) research and development (R&D) programs well into the next century.

DESCRIPTION: The NRL Airborne Surveillance Command and Control (ASC^2) research aircraft is a NP-3D aircraft integrated with a full E-2C AEW Hawkeye 2000 suite, which includes the full cooperative engagement capability (CEC). This heavyweight P-3B is configured with a Hawkeye 2000 Airborne Early Warning (AEW) system and an Airborne CEC suite to support the Navy's future AEW/CEC Network Centric Warfare programs. In addition to the AEW/CEC installation, there are floor and ceiling rails to accommodate six additional operator/equipment consoles in the aft crew compartment, a free-fall sonobuoy chute, space for mounting up to 700 lb of equipment in the forward equipment area, and cross-decked JTIDS Class II equipment. External wing wiring is installed, including fiber optics to support six external electronic pods. The nose radome area has been fitted for a modified IRDS (Infrared Radiation Detection System) turret that can be lowered and raised to support electro-optic projects. Additional structure mountings are in the nose and tail to accommodate the installation of project antennas. The aircraft can accommodate an additional internal payload of up to 2,800-lb external payloads of up to 10,000 lb and a crew of up to 16 people, including military flight crew and project scientists. The avionics suite includes a state-of-the-art, digitally controlled analog ICS system, dual INS, SATCOM, GPS, seven UHF, four VHF, and two high-power HF communications systems, all of which are secure communications capable and available for project use. Additionally, it is outfitted with four 90 KVA generators, wired to accommodate future growth of two 120 KVA generators.

CONTACT:
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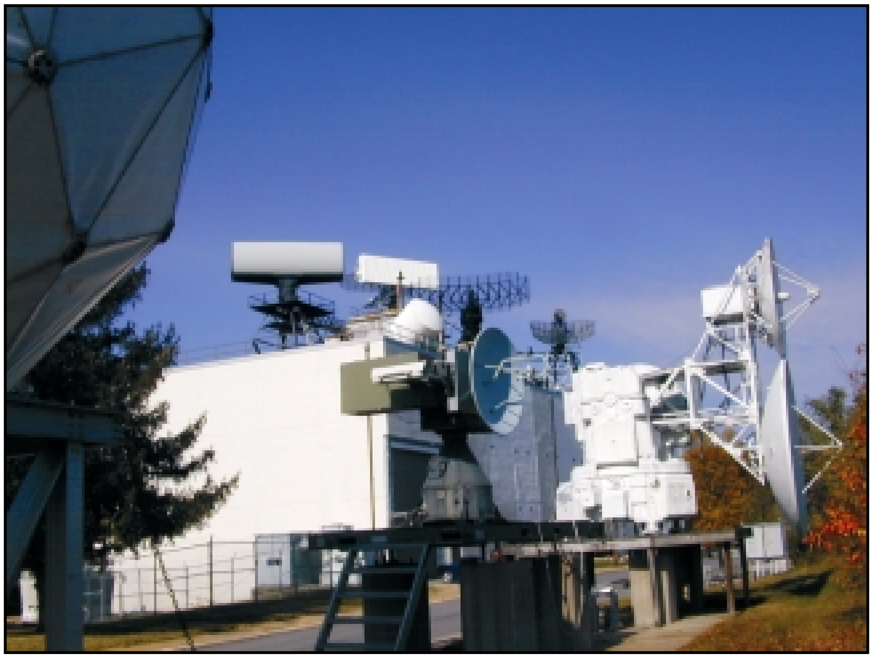
Bldg. 60, Rm. 210 • NRL, Washington, DC

Radar Test Facility



Radar antennas in front of and on the roof of Bldg. 75

FUNCTION: Tests and evaluates basic concepts and engineering developments in connection with target surveillance, tracking, and electronic countermeasures.

INSTRUMENTATION: Current instrumentation includes the SPS-49 radar; the Senrad radar, which uses a wideband array mounted back-to-back with the SPS-50 antenna; the SPS-55 and SPS-64 navigation radars; and antennas for the SPS-40 and SPS-10 radar systems. In front of the building are two precision tracking pedestals that were originally used for the FPS-16 and TPQ-27 radars but now have been modified for research use. Here also are two mobile research radar systems, the EDM version of the SPQ-9B and the engagement radar, an X-band phased array radar.

DESCRIPTION: The Radar Test Facility is on top of the cliff in front of Bldg. 75. Antennas are located on the ground and the roof for the numerous developmental and product-line radar systems. They provide a simulated naval scenario overlooking the Chesapeake Bay. Inside the building are the radar control rooms, transmitters, receivers, and data processing equipment.

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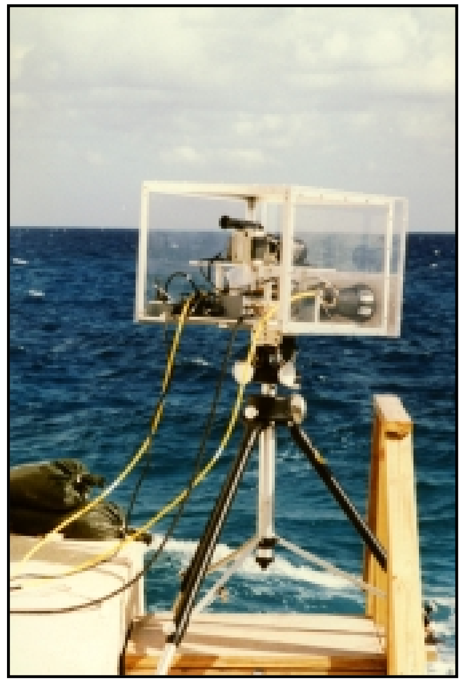
Microwave Microscope (MWM)


Front view


Rear view

Transmit-receive head deployed on field site at AUTEC

FUNCTION: Makes ultrahigh-resolution field measurements. The Microwave Microscope (MWM) has been used in support of several NRL experimental programs involving sea scatter and mine detection.

EQUIPMENT: The MWM consists almost entirely of commercial-off-the-shelf (COTS) equipment. Antenna housings and polarization switching logic were designed and built at NRL.

DESCRIPTION: The MWM, an ultrawideband, ultra-high-resolution, dual-polarized measurement radar system, has been designed, implemented, and used in the field to measure ocean surface scattering at X-band frequencies. This experimental system uses a video-excited TWT to produce 2 kW peak power transmit pulses as short as 150 ps in duration. Instantaneous receive bandwidths greater than 8 GHz are supported by a unique direct sampling detector that uses off-the-shelf digital sampling oscilloscope components. Data output consists of coherent I and Q measurements in a fixed number of range cells at resample periods as short as 25 µs. Final system range resolution is better than 2 cm. The system has been used at a field site at AUTEC, in the Bahamas, to measure ocean surface scatter under high-wind, rough-sea conditions.

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Advanced Technology Chamber (ATC)

Transmit/receive module assembly undergoing a radiated susceptibility assessment

FUNCTION: The NRL advanced technology chamber (ATC) is a welded aluminum shielded room (5.33 × 4.64 × 2.73 m). The ATC has two purposes: (1) as a mode stirred chamber to assess the electromagnetic (EM) susceptibility or emissions of electronic equipment and interfaces that might be installed on U.S. Navy ships or aircraft, and (2) as a research tool for investigating mode stirring phenomena.

INSTRUMENTATION: The ATC is support by the following instrumentation: (1) HP-8397 frequency synthesizer, (2) HP-8757D scalar network analyzer, (3) FM-1000 amplifier research electric field intensity meter, (4) Pentium 200 MHz Gateway PC, (5) assorted power amplifiers ranging in frequency from 100 MHz through 20.0 GHz, (6) computer-controlled stepper motor, (7) assorted antennas, and (8) microwave components.

DESCRIPTION: The ATC configured as a mode stirred chamber (MSC) excites a large number of different modes that characterize the distribution of the electric and magnetic fields from 200 MHz through 40 GHz. Mode stirring is accomplished by rotating a 1.0-m long aluminum stirrer that is situated just below the ceiling. The excitation of these large number of modes is the result of the changing boundary conditions on the rotating stirrer surfaces. The large number of modes provide a randomly polarized EM environment. The EM field within the chamber exhibits statistical uniformity for repeatability in measurements. Extremely large electric field intensity levels are achievable with modest amounts of input power due to the large Q factor (in excess of 50,000) that is presented by the aluminum cavity. Mode-stirred chambers have found wide acceptance for electromagnetic compatibility (EMC) susceptibility and emissions testing among the automotive and medical as well as the DoD communities. Recently, there has been a great deal of interest in electronic in place of mechanical stirring methods to expedite the measurement process. NRL is currently investigating a phase stirring approach where the excitation phases of three orthogonal wires are varied with respect to one another. An NRL patent (Application No. 82,622) has been applied for.

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